C

AEG

Evaluation of the Hawai‘i Energy Conservation and Efficiency Programs

Calendar Year 2022

Prepared for: Hawaii Public Utilities Commission

By: Applied Energy Group, Inc.

Date: January 30, 2024

AEG Key Contact: Kelly Marrin

This work was performed by:

Applied Energy Group, Inc.
2300 Clayton Road., Suite 1370
Concord, CA 94520

Project Director: K. Marrin
Project Manager: M. Buffum
TRM Update Lead: K. Parmenter

In consultation with the Hawaii Public Utilities Commission

Chief of Policy
& Research: G. Relf
EE Program Manager: A. Norman

And the Energy Efficiency Manager team

Project Team Lead: T. Pope
PBF EM&V Lead: T. Rasmussen
Jennifer Barnes

EXECUTIVE SUMMARY

This report presents the results of all *substantially* completed[1] Evaluation, Measurement, and Verification (EM&V) related activities associated with the Hawai'i Energy Conservation and Efficiency Programs (Hawai'i Energy programs) in the calendar year 2022 (CY22).[2] Further, it summarizes the most critical findings from the completed CY22 EM&V activities, focusing on implications for the Hawai'i Energy programs.

The EM&V work conducted for CY22 contributes to three overarching research objectives:

- **Verification of accomplishments:** Verifying Hawai'i Energy's PY21 achievements.
- **Robustness of savings approaches:** Updating and improving approaches used to estimate savings for Hawai'i Energy's programs and measures.
- **Program planning:** Using results to inform future program planning.

Approach

The EM&V-related research activities for CY22 were determined in consultation with the Hawaii Public Utilities Commission (HPUC) and the Energy Efficiency Manager (EEM).

The EM&V Contractor completed (or substantially completed) three research activities in CY22:

- Reviewing and updating the PY22 TRM
- Verifying Hawai'i Energy's PY21 program portfolio
- Finalizing the Custom Project Guidance Document

The EM&V Contractor also initiated two activities in CY22:

- Making mid-year updates to the PY22 TRM
- Reviewing and updating the PY23 TRM

The EM&V Contractor used various research and analysis methods. Table 1 summarizes the primary methods employed for each completed and initiated EM&V research activity.

Table 1 Summary of EM&V Research Activities and Methods for Work Completed or Initiated in CY22

EM&V Research Activity	Status at the end of CY22	Research and Analysis Methods	
PY22 TRM Major Update	Completed	• TRM updates review and approval	
PY21 Verification	Substantially Completed	• Documentation reviews • Program tracking system review and analyses • Sample design, selection, and extrapolation	• Engineering desk reviews • CBEEM onsite visits • Total resource benefit (TRB) analysis • Low-to-Moderate Income Performance Incentives Mechanisms analysis
Custom Project	Completed	• Document best practices for documentation and savings during implementation and verification of custom projects	

[1] From this point forward, "completed" work refers to work that was *substantially* completed during CY22, meaning that the EM&V Contractor completed the research and began drafting final deliverables during CY22. However, final approval of these "completed" activities may have occurred in CY22.

[2] Earlier versions of this report covered only activities completed during the prior program year (PY), July–June, and prior calendar year (CY). Starting with the CY20 version, the reports cover all CY activities initiated and substantially completed.

Guidance Document			
PY22 Mid-Year Update	Initiated	• TRM updates for new measures	• Changes to TRM for existing measures
PY23 TRM Major Update	Initiated	• Best practices research and benchmarking	• Measure and update prioritization

Key Findings and Implications

The EM&V Contractor completed two EM&V activities in CY22, the PY22 TRM Major Update and the PY21 verification of awards. The key findings and implications of these findings for the Hawai'i Energy programs follow.

PY22 TRM Major Update

Ongoing TRM updates have focused on improving the accuracy of deemed savings estimates and expanding the use of semi-prescriptive calculators to better customize savings for a given measure based on the specific installation characteristics (e.g., program delivery approach, equipment capacity, efficiency, building segment). The TRM updates also provide deemed savings for new measures.

In CY22, the EM&V Contractor completed updates to the PY22 TRM.

PY21 Verification

In CY21, AEG initiated and substantially completed the verification of Hawai'i Energy's claimed savings and performance for program year 2021 (PY21). The verification's chief purpose was to provide an independent review of Hawai'i Energy's performance relative to the contractually agreed-upon performance targets. The targets span a range of performance indicators, including energy and demand savings for Clean Energy Technologies (CET), Accessibility & Affordability (A&A), Market Transformation & Economic Development (MTED), and Customer Satisfaction. Successfully meeting the performance targets related to these indicators can lead to a financial award of up to $750,000 for Hawai'i Energy's implementer (Leidos).

AEG completed the verification using methods and activities consistent with past years, including savings replication, documentation and desk reviews, and program manager interviews. We worked with Hawai'i Energy to collect the data necessary for the verification and the Energy Efficiency Manager (EEM) and Commission to agree on the appropriate methods and activities.

In total, AEG found that Hawai'i Energy achieved 63% of the potential awards. Most shortfalls came from not meeting CET targets set for lifetime energy savings. Hawai'i Energy met all the non-CET performance metrics except for the A&A targets set for residential customer bill savings from hard-to-reach direct-install initiatives and program spending in the County of Maui, as well as the Sustained Outreach (under Behavior Change) and Innovation and Emerging Technologies targets set under the MTED performance area. Since Hawai'i Energy did not meet certain targets, they did not receive full awards in these areas.

The following summarizes the PY21 performance targets compared with Hawai'i Energy's claimed results and the verified results derived by the EM&V Contractor. Specifically:

- **Hawai'i Energy exceeded the target for installing Grid Service Ready measures which are a critical component of Hawaii's clean energy transition. AEG verified nearly 200% of the target, aligning with Hawai'i Energy's claimed amount.** The measures included not only grid-interactive water heaters but also smart devices, smart thermostats, and general demand response equipment.
- AEG found that **Hawai'i Energy's implementation of the TRM algorithms for prescriptive programs was nearly perfect.** We made minimal impactful TRM adjustments to the claimed savings, leading to TRM adjustment factors close to 1.0 for all programs.
- **Hawai'i Energy appears to be making incremental improvements to some of its calculators and tools based on past recommendations.** For example, the PY21 custom lighting calculator directly

calculated lifetime kWh savings, which are missing from the PY20 and previous calculators. That said, most of the sampled custom lighting projects still used the PY20 calculator, but AEG assumes it will be phased out over time.

- **The PBFA programs met or exceeded most, but not all, Clean Energy Technologies targets.**
  - Hawai'i Energy met the CET first-year and lifetime energy savings, demand savings, and TRBs targets for **Residential Hard-to-Reach and Residential Incentives** program categories.
  - **Business Custom** fell short of lifetime and TRB targets. Adjustments made during the verification contributed to the shortfall in lifetime energy savings, which accounted for nearly all the differences in claimed and verified awards. The TRBs reported by Hawai'i Energy fell short of the threshold before the verification made adjustments.
  - **Business Hard-to-Reach** also fell short of all but the peak demand reductions target. Hawai'i Energy and its customers continue to face challenges with supply chains and direct installation of measures because of the economic uncertainty and health concerns related to the pandemic.
  - **Business Prescriptive** exceeded targets for first-year energy and peak demand savings but fell short of lifetime energy savings and TRB targets. The verification did not impact these shortfalls.
- **Hawai'i Energy met all A&A performance targets except for residential bill savings and program spending in the County of Maui.** While Hawai'i Energy continued to face challenges related to the COVID-19 pandemic, they exceeded targets for residential and business A&A customers served. Even so, the residential A&A target for customer bill savings was missed by a wide margin, consistent with PY20, which suggests misalignment between the targets for customers served and the resulting savings on energy bills. Unlike PY20, the programs missed equity targets, falling short of the 13% target set for spending in the County of Maui (at 12%). In response to the HPUC's call for emergency demand response on Oahu, Hawai'i Energy prioritized projects in Honolulu County, which made achieving island equity in other counties more difficult.
- Similarly, **Hawai'i Energy PBFA programs met or exceeded targets for all MTED performance metrics except for the Sustained Outreach portion of Behavior Change and companies supported through Innovation and Emerging Technologies.** Further, they far exceeded targets in most other MTED focus areas.
- **AEG verified 100% of the claimed customer satisfaction scores of 9.6 and 9.4 for business and residential participant satisfaction, respectively.** Each metric exceeded the 9.0 target by over 104%.

Table 2 provides the key research findings from the PY21 verification and their implications for claimed values, which impacted Hawai'i Energy's awards.

Table 2 Key Research Findings and Their Implications/Outcomes: PY21 Verification

Key Result/Finding	Outcome
Thirty percent of BHTR lighting projects installed through Energy Advantage (small business direct install) incorrectly used the full baseline wattage to claim savings.	AEG used the correct efficient wattage (i.e., nonzero wattage) for these projects, which led to TRM adjustment factors of 0.96 for verified first-year energy savings and 0.97 for verified peak demand and lifetime energy savings.
Hawai'i Energy correctly applied the dual-baseline approach to calculate lifetime energy savings for BHTR Energy Advantage lighting projects that replaced halogen, incandescent, and pre-existing fluorescent equipment.	No adjustment needed. Unlike in previous program years, adjustments to Energy Advantage projects were generally unrelated to the dual-baseline approach and affected annual energy and peak demand savings similarly.
REEM upstream lighting and BEEM lighting and HVAC projects drove portfolio TRM adjustment factors. The savings replication found a TRM adjustment factor of 1.0 for these projects, heavily contributing to the	No adjustment needed. AEG verified nearly 100% of savings from these measures during the savings replication.

Key Result/Finding	Outcome
near-1.0 TRM adjustment factor for the residential programs overall.	
AEG found few systematic issues in documentation or savings reporting based on the simple desk reviews. Most systematic discrepancies were either fixed through the TRM adjustment or did not lead to changes in savings.	Adjustments made based on the simple desk reviews were largely trivial and expected given the large number of measures rebated through the programs (e.g., updating wattages in Energy Advantage).
Hawai'i Energy applied the PY21 TRM deemed savings for residential solar water heater projects to all homes with existing solar water heaters without first determining whether the project met the TRM eligibility requirements.	No adjustment made. Since the TRM does not provide clear guidance on how to determine the baseline equivalent capacity for solar water heater replacements, and because these replacements still generated energy savings, AEG allowed the projects to be verified at a 100% realization rate.
AEG could not determine whether all lamps and fixtures rebated through BEEM Midstream lighting program qualified for rebates. The different naming conventions between the invoices and qualifying products databases made it difficult to determine definitively whether some rebated lamps/fixtures were eligible for program rebates.	No adjustment made. AEG assumed that Hawai'i Energy performs this screen internally. Including evidence of this screening process would help AEG complete this verification more thoroughly.
During CBEEM onsite visits, AEG found all monitoring equipment had been removed from two chiller plant monitoring and optimization projects. While some of the optimization measures installed as a result of the monitoring were still in place, others could not be verified or were noted by the customer as never occurring. The lifetime savings had also used a 15-year EUL for an energy management system (EMS), meant for hotel guest room occupancy sensors and not optimization using an existing EMS.	The absence of the monitoring equipment put the persistence of these project savings into serious question. AEG only verified first-year savings for both projects based on the onsite inspections.
Lifetime savings calculations for one CBEEM lighting project were not included in the savings calculation workbook but appeared to be based on incorrect EULs and a single-baseline approach.	AEG used an approximation for the second baseline (45 lm/W as suggested by the PY22 TRM) to calculate lifetime savings and applied the correct EUL, leading to a 1.21 adjustment factor.
Two of the sampled CBEEM lighting projects that replaced incandescent fixtures incorrectly used a single baseline to calculate lifetime savings.	Using the dual baseline approach reduced lifetime savings for these measures by over 50%.
In two large multi-community residential housing upgrades, peak demand savings were calculated based on the per-kW rebate value instead of per-kW peak demand savings.	AEG corrected this error, which led to claimed savings realization rates of over 800% for both projects.
Hawai'i Energy did not follow industry best practices in regression modeling for three custom non-lighting projects by not weather-normalize savings, which is recommended in the Custom Project Guidance Document that will go into effect in PY22.	AEG developed adequate models showing the effect of weather on savings and estimated savings for a weather-normal year.
One sampled CBEEM project's savings were calculated using IPMVP Option C, an appropriate method for the type of upgrades that took place at the site. However, between the pre- and post-retrofit months, the site expanded its conditioned square	The AEG Team found that while the demand savings appropriately accounted for both events, the energy analysis did not account for either. The non-routine adjustment for the site expansion increased savings, but when combined with the removal of previously rebated

Key Result/Finding	Outcome
footage (a non-routine adjustment) and implemented two rebated lighting projects.	project savings, the AEG team verified 67% of the reported first-year and lifetime energy savings.
Hawai'i Energy used incorrect EULs for about 40% of custom non-lighting projects. In these cases, Hawai'i Energy used longer EULs based one measure within a bundle of measures installed at the site despite the TRM's guidance for calculating EULs for custom projects.	AEG used the PY21 TRM's deemed custom-project EUL for these projects. AEG made an exception for transformer projects (which used an EUL of 25 years) based on its professional engineering opinion that the deemed EUL is unreasonable for this type of upgrade.
AEG could not adequately verify savings using engineering best practices in any of the sampled non-lighting custom projects associated with a large energy efficiency initiative at several military housing communities. The supplemental project documentation did not include any of the raw data used to develop per-unit savings estimates, and AEG had to rely on the per-unit savings estimates developed by the implementation contractor. AEG was also limited to visiting vacant units during the onsite visits.	Not adjustments made (based on onsite visit or desk reviews). AEG feels that the substantial savings and incentives associated with these military housing opportunities (which included lighting upgrades, weatherization, and HVAC upgrades at more than 5,000 housing units) warrants a more robust verification of the initiative in full upon its completion. This would include identifying all opportunities associated with the military housing energy efficiency initiative and verifying the project as a whole, ideally with the time and budget required to sample vacant and occupied units from all affected communities.

Custom Project Guidance Document

In CY21, the EM&V Contractor drafted the Custom Project Guidance Document in a collaborative effort with Hawai'i Energy and the EEM. This document, which went into effect for PY22, clearly articulates expectations related to the EM&V of custom projects by providing both minimum requirements and optional best practices, with the goal of improving project implementation, tracking, and alignment with the verification. At the end of CY21, the document was largely completed and awaiting approval from the HPUC and Hawai'i Energy. It was approved in April 2022 (CY22) and placed on the Hawai'i Energy website.

PY22 Major TRM Update

In CY22, the EM&V Contractor initiated the review and prioritization process to gather and determine updates necessary for the PY22 TRM.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

This report presents the results of all Evaluation, Measurement and Verification (EM&V) related activities associated with the Hawai'i Energy Conservation and Efficiency Programs (Hawai'i Energy programs) initiated or completed during the prior calendar year (CY), 2022 (referred to as CY22).[3] This report also summarizes the most important findings from the completed CY22 EM&V activities, with a focus on implications for the Hawai'i Energy programs.

Research Objectives

The EM&V work conducted for CY22 contributes to three overarching research objectives:

- **Verification of accomplishments:** Verifying Hawai'i Energy's PY21 achievements.
- **Robustness of savings approaches:** Updating and improving approaches used to estimate savings for Hawai'i Energy's programs and measures.
- **Program planning:** Using results to inform future program planning.

EM&V Research Activities

The EM&V-related research activities for CY22 were determined in consultation with the Hawaii Public Utilities Commission (HPUC) and the Energy Efficiency Manager (EEM).

The EM&V Contractor completed (or substantially completed) three research activities in CY22:

- Reviewing and updating the PY22 TRM
- Finalizing the Custom Project Guidance Document

One activity was initiated in CY22:

- Verifying Hawai'i Energy's PY21 program portfolio
- Reviewing and updating the PY22 TRM

The remainder of the report first presents an overview of the PY21 Verification of Hawai'i Energy's portfolio. Subsequently, we offer a summary of the two TRM tasks that were completed and initiated.

[3] Earlier versions of this report covered activities completed during the prior program year (PY), July–June, and prior calendar year. Starting with the CY19 version, the reports cover only prior CY activities, both initiated and completed, as opposed to who le program years

PY21 VERIFICATION

The Hawaii Public Utilities Commission (the Commission) contracted the EM&V Contractor (Applied Energy Group [AEG]) to verify the savings and performance of Hawai'i Energy's Public Benefits Fee Administrator (PBFA) programs in the program year 2021 (PY21, July 1, 2021, to June 30, 2022). PY21 marked Hawai'i Energy's third year in the Triennial Plan for program years 2019 to 2021 (PY19-21) and its 11th year implementing energy efficiency programs as a Public Benefits Fee Administrator (PBFA). The EM&V Contractor verified whether Hawai'i Energy met the targets for the performance indicators and key focus areas (listed in Table 3 and Table 4), which determined the performance awards that Hawai'i Energy was eligible to receive in PY21.

This chapter summarizes the PY21 verification approach, results, and recommendations. More detailed information on the verification can be found in the Hawai'i Energy PY21 Verification Report[4] located on the Hawai'i Energy website (https://hawaiienergy.com/about/information-reports).

Approach to Verification

Verification activities included a tracking database review, savings replication for deemed and semi-deemed measures, engineering desk reviews, and onsite visits for custom projects, as well as documentation reviews to verify program funding equity, engagement with hard-to-reach communities, and customer satisfaction. The EM&V Contractor used the methods shown in Table 3 and Table 4 to verify PY21 performance in the Clean Energy Technologies (CET) and non-CET key performance areas, respectively. Non-CET performance areas include Accessibility & Affordability (A&A), Market Transformation & Economic Development (MTED), and Customer Satisfaction.

The EM&V Contractor did not design PY21 verification activities to review the validity of the TRM's stipulated savings or adjustment factors, only to assess whether Hawai'i Energy applied them appropriately when calculating claimed values for the PY21 programs. Therefore, our verification does not scrutinize measure-level gross savings values or associated adjustments beyond ensuring the correct application of TRM-stipulated savings and factors and documentation of incented measures through desk reviews.[5]

PY21 methods mostly aligned with those used during the PY20 verification. Key differences in methods from PY20 included:

- Includes 30 onsite visits for custom projects
- Extended reporting timeline to accommodate the completion of 30 onsite visits

Table 3 PY21 CET Verification Methods

Performance Metric	**Description of Metric**	**Verification Activities and Adjustments**
Energy and Demand Savings First-Year Energy Savings Lifetime Energy Savings Peak Demand Reductions	**Customer-Level Savings** Gross savings for each customer before accounting for line losses or what the customer would have done absent the program (i.e., no application of a net-to-gross ratio at this step)	**TRM Adjustment** through a savings replication for all deemed and semi-prescriptive measures in the tracking database **Desk Review Adjustment** through engineering desk reviews on a sample of custom and non-custom projects **Onsite Adjustment** through in-person site visits to spot check key savings estimation

[4] Hawai'i Energy PY2021 Verification Report, Prepared by Applied Energy Group, Prepared for Hawaii Public Utilities Commission, July 18, 2023. (This report has not been published yet.)

[5] AEG compared Hawai'i Energy database information to the PY21 TRM V1.0 information.

Performance Metric	Description of Metric	Verification Activities and Adjustments
		parameters and confirm the installation and operation of rebated equipment.
	System-Level Savings Savings reflected at the generator incorporating line losses	**System-Loss Adjustment** through a review of the system loss factors (in PY21 TRM V1.0) applied to the customer-level savings
	Program-Level Savings Net savings that account for free-ridership and spillover (system-level savings multiplied by the net-to-gross ratio)	**Net-to-Gross (NTG) Adjustment** through a review of the NTG ratios (in PY21 TRM V1.0) applied to the system-level savings
Total Resource Benefits	The estimated total net present value (NPV) of the avoided cost for the utility from the reduced lifetime demand (kW) and energy (kWh) from energy efficiency projects and measures	**TRB Adjustment** using customer-level verified savings and NTG ratios to calculate TRBs for each program and measure (avoided costs already include line losses so are not included in savings at this step). Avoided costs as stipulated in PY21 TRM V1.0.
Grid Services Products	The total number of projects completed or products installed that qualify as Grid Service Ready (e.g., grid-connected water heaters)	**Product Adjustment** using the count of Grid Services Products included in the reconciled tracking database.
GHG Reductions	The avoided emissions and equivalent avoided barrels of oil due to program-level annual energy savings	**GHG Avoided Emissions Adjustments** using the program-level verified savings and metric tons-per-kWh and barrels of oil-to-metric tons conversion factors provided in the PY21 TRM.

Table 4 PY21 Non-CET Verification Methods

Performance Area	*Metric*	*Verification Approach*
Affordability & Accessibility		
	Economically Disadvantaged Requires serving a minimum number of customers (who save a minimum amount on their energy bills) through the Energy Advantage and single- and multi-family direct install programs, distinct communities through the Community-Based Energy Efficiency program, and nonprofits through the EmPOWER Hawaii Project.	**Energy Advantage**. Confirmed customer counts in the tracking database **Single Family/Multifamily Direct Install.** Confirmed customer counts in the tracking database and calculated customer bill savings using average Hawaiian Electric rates and 2019 customer billing data **Community-Based Energy Efficiency.** Confirmed community counts through project documentation review **EmPOWER Hawaii Project.** Confirmed number of projects by reviewing contractor invoices
	Island Equity Requires that 13 percent of program spending occurs in each of Hawaii and Maui counties.	Confirmed equitable distribution of funds by reviewing program spending by island (program tracking database includes a variable that states the island for each rebate).
Market Transformation & Economic Development	**Behavior Change** **Professional Development & Technical Training** **Energy in Decision Making** **Codes & Standards** **Clean Energy Innovation Hub**	Reviewed contractor invoices, attendance records, participant agreements, and other backup documents
Customer Satisfaction	**Residential Customer Satisfaction** **Business Customer Satisfaction**	Reviewed survey results from Medallia and in-house survey tools.

Verification Results

In total, Hawai'i Energy achieved 63% of the potential awards. Most shortfalls came from not meeting CET targets set for lifetime energy savings (see Figure 1). Hawai'i Energy met all the non-CET performance metrics except for the A&A targets (see Figure 2) set for residential customer bill savings from hard-to-reach direct-install initiatives and program spending in the County of Maui, as well as the Sustained Outreach (under Behavior Change) and Innovation and Emerging Technologies targets set under the MTED performance area (see Figure 3). Since Hawai'i Energy did not meet certain targets, they did not receive full awards in these areas.

Table 5 summarizes the PY21 performance targets compared with Hawai'i Energy's claimed results and the verified results derived by the EM&V Contractor. Specifically:

- **Hawai'i Energy exceeded the target for installing Grid Service Ready measures which are a critical component of Hawaii's clean energy transition.** AEG verified nearly 200% of the target, aligning with Hawai'i Energy's claimed amount. The measures included not only grid-interactive water heaters but also smart devices, smart thermostats, and general demand response equipment.
- AEG found that **Hawai'i Energy's implementation of the TRM algorithms for prescriptive programs was nearly perfect.** We made minimal impactful TRM adjustments to the claimed savings, leading to TRM adjustment factors close to 1.0 for all programs.
- **Hawai'i Energy appears to be making incremental improvements to some of its calculators and tools based on past recommendations.** For example, the PY21 custom lighting calculator directly calculated lifetime kWh savings, which are missing from the PY20 and previous calculators. That said, most of the sampled custom lighting projects still used the PY20 calculator, but AEG assumes it will be phased out over time.

- **Hawai'i Energy met all A&A performance targets except for residential bill savings and program spending in the County of Maui.** While Hawai'i Energy continued to face challenges related to the COVID-19 pandemic, they exceeded targets for residential and business A&A customers served. Even so, the residential A&A target for customer bill savings was missed by a wide margin, consistent with PY20, which suggests misalignment between the targets for customers served and the resulting savings on energy bills. Unlike PY20, the programs missed equity targets, falling short of the 13% target set for spending in the County of Maui (at 12%). In response to the HPUC's call for emergency demand response on Oahu, Hawai'i Energy prioritized projects in Honolulu County, which made achieving island equity in other counties more difficult.
- Similarly, **Hawai'i Energy PBFA programs met or exceeded targets for all MTED performance metrics except for the Sustained Outreach portion of Behavior Change and companies supported through Innovation and Emerging Technologies.** Further, they far exceeded targets in most other MTED focus areas.
- **AEG verified 100% of the claimed customer satisfaction scores of 9.6 and 9.4 for business and residential participant satisfaction, respectively.** Each metric exceeded the 9.0 target by over 104%.

The remainder of this section of the report details the key findings from the CET and non-CET verification activities.

Table 5 PY21 Claimed and Verified Performance Award by Performance Indicator

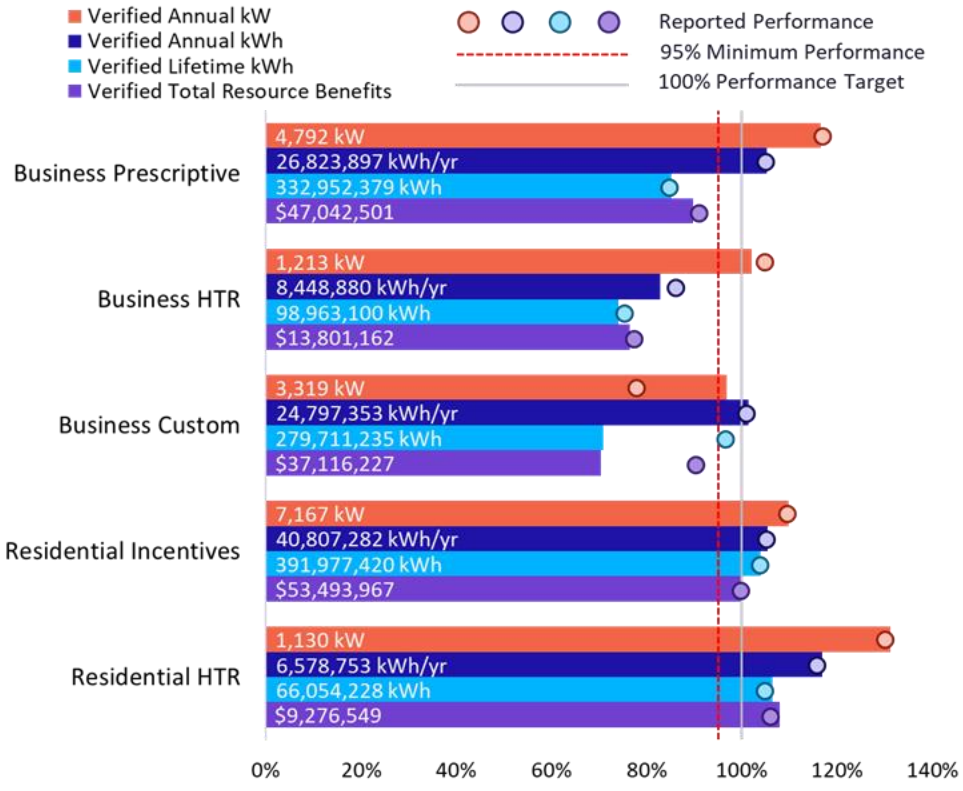
Performance Indicator	Performance Target	Metric	Fraction of Award	Target Award	Claimed Results			Verified Results		
					Performance	Percentage of Performance Target	Award	Performance	Percentage of Performance Target	Award
Clean Energy Technologies - Key Focus Areas[1]			**70.00%**	**$525,000**		**65.9%**	**$345,983**		**65.0%**	**$341,112**
First Year Energy Reduction	104,531,117	kWh	15.00%	$112,500	107,475,477	102.8%	$106,192	107,456,165	102.8%	$106,449
Lifetime Energy Reduction	1,358,488,174	kWh	15.00%	$112,500	1,269,465,046	93.4%	$57,412	1,169,658,362	86.1%	$37,939
Peak Demand Reduction	16,125	kW	15.00%	$112,500	17,001	105.4%	$98,523	17,621	109.3%	$112,729
Total Resource Benefit	$185,408,727	$	20.00%	$150,000	$171,869,271	92.7%	$46,355	$160,730,405	86.7%	$46,495
Grid Services Ready (new)	1,000	projects/ demand management products installed or customers served	5.00%	$37,500	1,896	189.6%	$37,500	1,892	189.2%	$37,500
Greenhouse Gas Emissions/ Barrel of Oil	74,095 / 170,968	tons / barrels	0.00%	$0	74,168 / 172,569	100.1% / 100.9%	$0	76,168 / 177,135	102.8% / 103.6%	$0
Accessibility & Affordability - Key Focus Areas			**20.00%**	**$150,000**		**40.0%**	**$60,000**		**40.0%**	**$60,000**
Economically Disadvantaged										
Business A&A (Energy Advantage, Energy Relief Grant)										
Customers Served	550	Customers served	2.00%	$15,000	619	113%	$15,000	617	112%	$15,000
Bill Savings	$1,100,000	Customer bill savings (annual)	2.00%	$15,000	$2,067,829	188%	$15,000	$2,310,136	210%	$15,000
Residential A&A (Single & Multifamily Direct Install, Water Heating Direct Install, Bulk Appliances)										
Customers Served	2,000	Customers served	2.00%	$15,000	2,193	110%	$15,000	2,193	110%	$15,000
Bill Savings	$5,400,000	Customer bill savings (lifetime)	2.00%	$15,000	$3,152,818	58%	$0	$2,793,390	52%	$0
Community Based Energy Efficiency (new)	4	Communities served	1.00%	$7,500	5	125%	$7,500	5	125%	$7,500
EmPower Hawai'i Project (new)	7	Participating non-profits	1.00%	$7,500	8	114%	$7,500	8	114%	$7,500
Island Equity										
County of Hawaii	13%	Target spend must be met in Hawaii & Maui Counties for Milestone & Target Award	10.00%	$75,000	13.2%	102%	$0	13.2%	102%	0%
County of Maui	13%				12.4%	95%		12.4%	95%	
City & County of Honolulu	74%				74.4%	101%		74.4%	101%	
Economic Development & Market Transformation - Key Focus Areas			**8.00%**	**$60,000**		**100.0%**	**$60,000**		**100.0%**	**$60,000**
Behavior Change										
Workshop and Presentations										
STEM based student workshop	1,200	Number of participant-hours of Training	1.00%	$7,500	1,406	117%	$7,500	1,376	115%	$7,500
Adult learning	2,500	Number of participant-hours of Training	1.00%	$7,500	3,051	122%	$7,500	3,027	121%	$7,500
Gamification Campaigns and Competitions	700	Number of participants	0.00%	$0	1,300	186%	$0	1,300	186%	$0
Exhibit Educational Resources	0	Number of Stakeholder Collaboration Events	0.00%	$0	0	n/a	$0	0	n/a	$0
Sustained Outreach	2	Participation Agreements	0.00%	$0	0	0%	$0	0	0%	$0
Behavioral Insights	0	Number of Program Interventions	0.00%	$0	0	n/a	$0	0	n/a	$0
Professional Development & Technical Training										
Clean Energy Ally Support										
Targeted Ally Training Opportunities										
Targeted Participant Training Opportunities	7,000	Number of participant-hours of Training	4.00%	$30,000	7,313	104.5%	$30,000	7,298	102.8%	$30,000
Educator Training and Grants										
Degree Program Support										
Vocational Training										
Energy in Decision Making										
Strategic Energy Management (SEM)	4	Number of new participating institutions	1.00%	$7,500	4	100.0%	$7,500	4	100.0%	$7,500
Codes and Standards										
Appliance Standards Advocacy (new)	3	Advocacy Events	1.00%	$7,500	6	200.0%	$7,500	6	102.8%	$7,500
Improve Code Compliance	1	Establishing compliance roadmap and tracking savings			1			1		
Code-Related Training	50	Number of participant-hours of Training			50			50		
Leading edge technologies and strategies	2	Meeting and one final report			2			2		
Clean Energy Innovation Hub										
Innovation and Emerging Technologies	1	Companies supported	0.00%	$0	1	100.0%	$0	1	100.0%	$0
Customer Satisfaction - Key Focus Areas			**2.00%**	**$15,000**		**100.0%**	**$15,000**		**100.0%**	**$15,000**
Application Processing Customer Experience - Commercial	>9	Overall customer satisfaction score	1.00%	$7,500	9.6	106.7%	$7,500	9.6	106.7%	$7,500
Application Processing Customer Experience - Residential	>9	Overall customer satisfaction score	1.00%	$7,500	9.4	104.4%	$7,500	9.4	104.4%	$7,500
Total Performance Award			**100%**	**$750,000**		**64%**	**$480,983**		**63%**	**$476,112**

[1]Note that to achieve CET awards for first-year and lifetime energy savings, peak demand reductions, and total resource benefits, Hawai'i Energy must meet performance thresholds in specific program categories. Therefore, even though Hawai'i Energy exceeded first-year energy and peak demand savings targets overall, they missed performance targets in some program categories and did not achieve 100% of these awards. See Appendix A: Detailed Performance and Awards Tables for details on performance and awards targets.

Figure 1 shows Hawai‘i Energy PBFA program verified performance against CET performance indicator targets for first-year and lifetime energy savings, peak demand reductions, and total resource benefits ($). The verification findings show the following with respect to the CET targets:

- **Hawai‘i Energy met the CET first-year and lifetime energy savings, demand savings, and TRBs targets for Residential Hard-to-Reach and Residential Incentives program categories.**
- **Business Custom fell short of lifetime and TRB targets**. Adjustments made during the verification contributed to the shortfall in lifetime energy savings, which accounted for nearly all the differences in claimed and verified awards. The TRBs reported by Hawai‘i Energy fell short of the threshold before the verification made adjustments.
- **Business Hard-to-Reach also fell short of all but the peak demand reductions target.** Hawai‘i Energy and its customers continue to face challenges with supply chains and direct installation of measures because of the economic uncertainty and health concerns related to the pandemic.
- **Business Prescriptive exceeded targets for first-year energy and peak demand savings but fell short of lifetime energy savings and TRB targets.** The verification did not impact these shortfalls.

Figure 1 Achievement of Performance Targets for Clean Energy Technologies for PY21



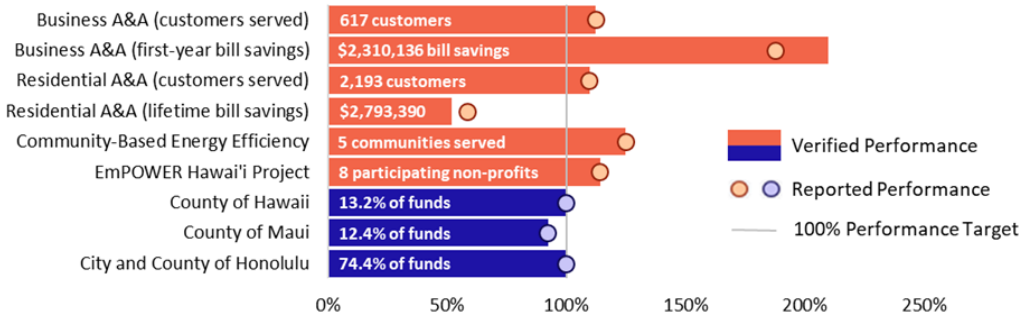
As shown in Figure 2, Hawai‘i Energy met all **Economically Disadvantaged** performance targets except for residential customer lifetime bill savings. Consistent with PY20, both the reported and verified bill savings barely reached 50% of target despite exceeding all RHTR CET targets. Only a subset of the RHTR programs contribute to the residential A&A targets, including direct-install channels and bulk appliances trade-ins. This suggests that either that Hawai‘i Energy is meeting RHTR targets through primarily non-A&A channels or that the CET targets set for RHTR are too low to meet the bill savings target.

Hawai‘i Energy also did not achieve **Island Equity** awards because incentive spending for the County of Maui fell short of the performance target. In response to the HPUC’s call for emergency demand response

on Oahu, Hawai'i Energy prioritized projects in Honolulu County, which made achieving island equity in other counties more difficult.

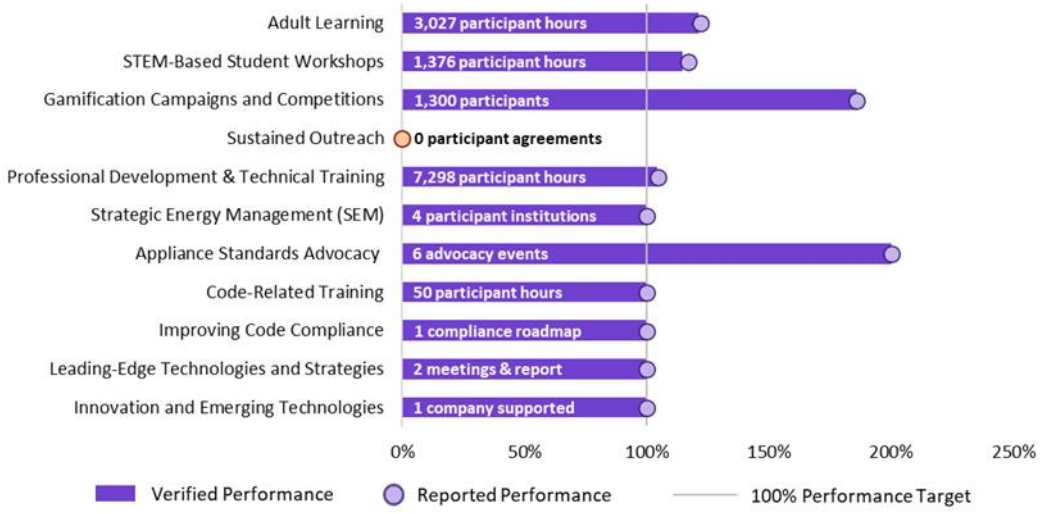
Consistent with the verification, Hawai'i Energy did not claim awards for these two key focus areas.

Figure 2 Achievement of Performance Targets for Accessibility & Affordability for PY21



AEG verified MTED activities and achievements by reviewing contractor invoices, participant agreements, virtual workshop rosters and screengrabs, and other backup documents. As shown in Figure 3, Hawai'i Energy met all MTED performance targets except for Sustained Outreach within the Behavior Change category. In its interviews with AEG, program staff indicated that Sustained Outreach efforts were being phased out and rolled into the Community-Based Energy Efficiency (CBEE) program with the A&A Economically Disadvantaged key focus area. The CBEE program achieved its target number of communities served (see Figure 2).

Figure 3 Market Transformation & Economic Development Verified Performance



One of Hawai'i Energy's performance targets relates to customers' satisfaction with their rebate experience. To measure residential participant satisfaction, Hawai'i Energy uses the customer management tool Medallia, which sends customers an automated email survey soliciting feedback on their experience with a variety of program interaction elements. For business participants, Hawai'i Energy sends monthly surveys to new participants through an in-house customer experience management tool.

Recommendations

Based on the verification activities, the EM&V Contractor developed a set of recommendations for Hawai'i Energy to consider. Table 6 documents the recommendations made by the AEG team beginning in PY17 that remain relevant along with new recommendations based on the PY21 verification. Additional

recommendations may have been made over the past five evaluations; however, either they were implemented by Hawai'i Energy, or they are no longer relevant for another reason, i.e., change in awards, targets, or focus.

Table 6 Verification Recommendations

Recommendation	PY17	PY18	PY19	PY20	PY21	Comments
Continuing Recommendations						
Account for dual baselines when calculating Lifetime Energy savings and TRBs.			X	X	X	AEG saw improvement over PY20, particularly in RHTR, however adjustments were still made in BEEM and CBEEM.
Collect Invoices (or an equivalent form of documentation) for all measures and projects prior to paying out incentives.		X	X	X	X	AEG saw little improvement over PY21 particularly for custom projects.
When using regression models to estimate annual savings for custom projects, ensure that models incorporate sufficient data from both the pre- and post-implementation period to cover the range of operating conditions experienced in a typical year and produce accurate and precise savings estimates.		X		X	X	Failure to make changes based on this recommendation led to adjustments for four sampled non-lighting projects.
Ensure all data is collected and tracked so that semi-prescriptive savings can be replicated.			X	X		AEG did not see this as an issue in the PY21 verification.
Ensure site inspections are sufficiently rigorous to verify measure type and quantity.		X	X	X	X	Post-installation site inspections often do not collect sufficient data to verify the type and quantity of all measures. This issue has been significant and ongoing for custom and new construction projects.
Consider using typical meteorological year (TMY) weather data when using regression analysis to estimate lifetime savings for custom projects.				X	X	Using TMY is a best practice and conforms with the Custom Project Guidance Document.
Collect supplemental project documentation before paying out incentives for projects.				X	X	This is a documentation best practice that conforms with the Custom Project Guidance Document.
Include project descriptions for custom projects.				X	X	This is a documentation best practice that conforms with the Custom Project Guidance Document.
Consider collecting DLC screenshots consistently for all custom lighting projects.				X	X	This allows the project team to confirm eligibility for rebated

Recommendation	*PY17*	*PY18*	*PY19*	*PY20*	*PY21*	*Comments*
						fixtures, it was an issue in the BEEM midstream desk reviews.
Beginning in PY21, use the updated baseline to calculate savings for residential faucet aerators and showerheads.				X		AEG did not see this issue in the PY21 Verification
New Recommendations						
Adhere to Custom Project Guidance					X	It will be critical for projects to adhere to the custom project guidance document beginning in PY22. AEG's analysis shows that approximately half of the PY21 CBEEM projects would be assigned zero savings for lack of conformance.
For solar water heater replacements in residential homes, calculate the equivalent electric resistance water heater capacity to determine whether the replacement qualifies for the deemed savings value provided in the TRM (and use a custom baseline if not).					X	We believe that many of the replacements did not qualify for deemed savings and should use a custom baseline. Alternatively, the TRM could be expanded to include larger units.
Consider a net-to-gross study for CBEEM.					X	Findings suggest that the current assumed NTG of 75% could be too high for CBEEM.
Future TRM updates should allow certain projects, such as custom transformers, to use longer measure lives than currently deemed for custom projects in the TRM.					X	This would allow a more accurate assessment of lifetime savings for these projects.
Clearly investigate, document, and remove savings from previously-rebated projects when using metered or utility billing data as needed to estimate custom project savings.					X	Doing so avoids double-counting savings between program years and paying incentives for the same projects multiple times.

TRM UPDATES AND RELATED RESEARCH

This chapter summarizes CY22 activities related to the review and update of Hawai'i Energy's TRM.

PY22 TRM Update

The EM&V Contractor completed the planning, receiving input, and prioritizing updates steps for the PY22 major review and update in CY2021. The updates were based on findings from the TRM Review and Recommendations Review and completed the draft update, review and feedback, additional adjustments, and then received final approval from the HPUC in early CY2022.

Custom Project Guidance Document

In CY21, the EM&V Contractor drafted the Custom Project Guidance Document in a collaborative effort with Hawai'i Energy and the EEM. This document, which went into effect for PY22, clearly articulates expectations related to the documentation and savings during the implementation and verification of custom projects. Specifically, it defines custom projects, describes program rules, and provides guidance on the following:

- Project documentation and data collection
- Energy savings estimation approach
- Impact evaluation of custom programs

The document includes both minimum requirements and optional best practices, with the goal being improved project implementation, tracking, and alignment with the verification. Findings from verification and TRM review efforts informed many of the topics in the Custom Project Guidance Document. The HPUC and Hawai'i Energy formally approved it in CY22.

Mid-Year PY22 TRM Update

The TRM Framework allows for mid-year additions to the TRM if the requests are submitted and approved prior to implementation of the new or expanded measures.[6] The purpose of the mid-year PY22 TRM update was to review any recommendations and add the new or modified measure entries for all opportunities approved by the HPUC into a new version of the PY22 TRM, referred to as PY22 TRM v2.0. In accordance with guidance provided in the TRM Framework related to mid-year updates, the EM&V Contractor reviewed the recommended mid-year TRM updates. Because all recommended updates fit within the budget currently set aside for mid-year additions, EM&V Contractor granted all requests. Upon approval by the Energy Efficiency Manager (EEM) and HPUC, the EM&V Contractor carried out the mid-year TRM updates. It went into effect in early CY23.

The mid-year updates to the PY22 TRM included the following:

- **Residential Central AC Retrofit:** This mid-year update adds a new measure entry that reflects new SEER2 and EER2 baseline values and updated energy efficiency criteria for residential central AC system retrofits. SEER2 and EER2 are based on a new AHRI test method that is different than the test method used for SEER and EER. The new test method, referred to as the Appendix M1 Test Procedure, increases the system's external static pressure by a factor of 5 (from 0.1 in. to 0.5 in. of H_2O) to represent actual installed conditions more accurately. Residential-scale single-phase AC systems installed on or after January 1, 2023, must meet the new SEER2 requirements.[7] Therefore, the new measure has an effective date of January 1, 2023. The previous measure will be used for AC systems installed through December 31, 2022. The update

[6] Hawai'i Energy Technical Reference Manual Framework, Version 1.1, June 1, 2020, Effective July 1, 2019 (superseded Version 1.0). See Section 3.4 Mid-Program Year Additions and Modifications.

[7] For Hawaii, there are no federal or state minimum EER or EER2 requirements for AC systems, but AEG determined proxy baseline EER and EER2 values to use for estimating peak demand impacts.

also involved using AHRI data[8] to determine appropriate SEER-to-SEER2 and EER-to-EER2 conversion factors for use in the TRM entry and program communications.

- **Residential Ductless Split Systems:** This mid-year update adds a new measure entry that 1) reflects new SEER2 baseline values for ≥ 30 kBtu/h systems, 2) clarifies and corrects the combined energy efficiency rating (CEER) baseline values for < 30 kBtu/h systems, and 3) updates the relationship between CEER and EER and SEER(2) and EER(2) for residential ductless split systems. The new measure will be used for systems installed on or after January 1, 2023. The previous measure will be used for systems installed through December 31, 2022.
- **Residential HVAC Savings Calculator:** This mid-year update creates a new calculator that incorporates the above changes for the Central AC Retrofit and Ductless Split System measures. It also adds a separate line item for replace-on-burnout lifetime savings. The previous worksheet only calculated early replacement lifetime savings.
- **Residential LED:** This mid-year update temporarily revises the dual baseline LED measure for underserved markets (specifically Molokai and Lanai), making it active for PY22, but only through March 2023. One of the reasons for the update is to address input from former Commissioner Potter. While still a Commissioner, she encouraged Hawai'i Energy to conduct more community-based outreach on Molokai and Lanai to distribute LEDs, since smaller communities such as these are more likely to have a remaining/stranded inventory of Tier 1 lamps. The assumption is that distributors/retailers may not switch to Tier 2 lamps until they "have to" (i.e., until they start receiving penalties for non-compliance, which is expected in March 2023).[9]
- **C&S Tracking Sheet:** This mid-year update revises spreadsheet content and organization to reflect current codes and standards applicable as of PY22. It also adds some additional types and capacities of commercial HVAC equipment for completeness.
- **Net-to-Gross Ratios:** This mid-year update adds NTGRs for the RGRID and BGRID programs. Hawai'i Energy proposed an NTGR of 1 for each program "based on the relative newness of these initiatives and the heavy incentive push."[10] In PY22, Hawai'i Energy is planning to claim kW savings under BGRID for demand-shifting energy storage measures and traditional kW and kWh savings for demand response (DR)-capable heat pump water heaters. Savings from RGRID initiatives may come in the future. In conducting this update, AEG searched for but was unable to find comparable programs to use as benchmarks. However, AEG agrees that NTGRs of 1 are reasonable for the types of equipment involved (battery storage and grid-interactive water heaters) and the newness of the grid service offerings, especially since the customers are getting substantial incentives for installing equipment and shifting loads.[11]
- **Commercial LED Downlight Retrofit:** This measure was added to the PY22 TRM during the annual update process. There previously was some ambiguity in its applicability. Hawai'i Energy and AEG discussed that the measure entry was intended to apply only to the replacement of incandescent, halogen, and CFL bulbs. When the baseline lamp is a metal halide or high-pressure sodium lamp, the Commercial HID measure within the Commercial General lighting sheet of the TRM should be used to estimate savings. This mid-year update clarifies applicability.
- **LED Retrofit Kit Engines:** The mid-year updates add language to several measures in the TRM to explain that LED retrofit kit engines qualify as applicable LED replacement lighting (as an alternative to more traditional LED bulbs or tubes), as long as the LED retrofit kit engines have appropriate form factors compared to the baseline lighting. When carrying out this update, AEG added language that reflects the

[8] Air-Conditioning, Heating, & Refrigeration Institute (AHRI), Database of Certified Products, accessed Nov. 7 2022, available here: https://www.ahridirectory.org/.

[9] See: https://www.energy.gov/gc/articles/general-service-lamps-enforcement-policy.

[10] Email exchanges between Vinh-Phong Ngo and Kelly Parmenter, 5/10/22 and 11/10/22.

[11] For example, refer to Hawai'i Energy's program documentation for the Power Move Commercial Energy Storage program for more information on the program participation requirements and incentives for load-shifting energy storage measures (available here: https://hawaiienergy.com/for-business/power-move).

final EISA rulings,[12] as applicable for the given measures. In addition, for clarity, we changed references to "Corn Cob" lighting to "HID Replacement" lighting in the Commercial General lighting sheet.

- **Energy Advantage:** This mid-year update corrects a typo in the Energy Advantage sheet. Equation 4 should say "ΔkWh1st" instead of "ΔkWh2nd."
- **Residential Heat Pump Water Heater:** This mid-year update adds an option to the semi-prescriptive calculator to enter a custom occupancy value.

PY23 TRM Update (Initiated)

The Hawai'i Energy TRM Framework calls for an annual review and update of TRM content. The workflow includes seven steps, three of which were completed in CY22:

- Completed in CY22
  - Annual TRM update planning
  - Input on updates
  - Prioritization
- To complete in CY23
  - Draft TRM updates
  - Review and feedback
  - TRM adjustments
  - Final TRM presented for HPUC approval

During CY2022, the EM&V Contractor completed the first three steps (planning, receiving input, and prioritizing updates) for the PY23 TRM review and update.

After first developing a plan for the PY23 TRM updates, the EM&V Contractor compiled a preliminary list of measures and content to consider in the review and update process. The EM&V Contractor identified these items during previous TRM updates and PY21 Verification and through correspondence with Hawai'i Energy, the EEM, and the HPUC. The EM&V Contractor next requested additional input on the preliminary list of update ideas from the Technical Advisory Group (TAG) and then compiled all suggested updates into a comprehensive list for prioritization. This process resulted in a list of 82 potential items to review and update. Using four criteria to score each suggested update and considering the level of effort and time required for each update, the EM&V Contractor recommended a "short list" of updates for the PY23 TRM update.[13] The EM&V Contractor began the update process for the PY23 TRM in January of CY23.

[12] U.S. Department of Energy, Final Rulings, May 9, 2022, Federal Register 87FR27461 and 87FR27439, available here: https://www.federalregister.gov/.

[13] Prioritization of Program Year PY23 TRM Updates_1-10-23_Final, Memorandum, Prepared by Applied Energy Group, Prepared for Energy Efficiency Manager (EEM), Hawaii Public Utilities Commission (HPUC), and Hawai'i Energy, January 10, 2023.

Applied Energy Group, Inc.
2300 Clayton Road, Suite 1370
Concord, CA 94596

P: 510.982.3525